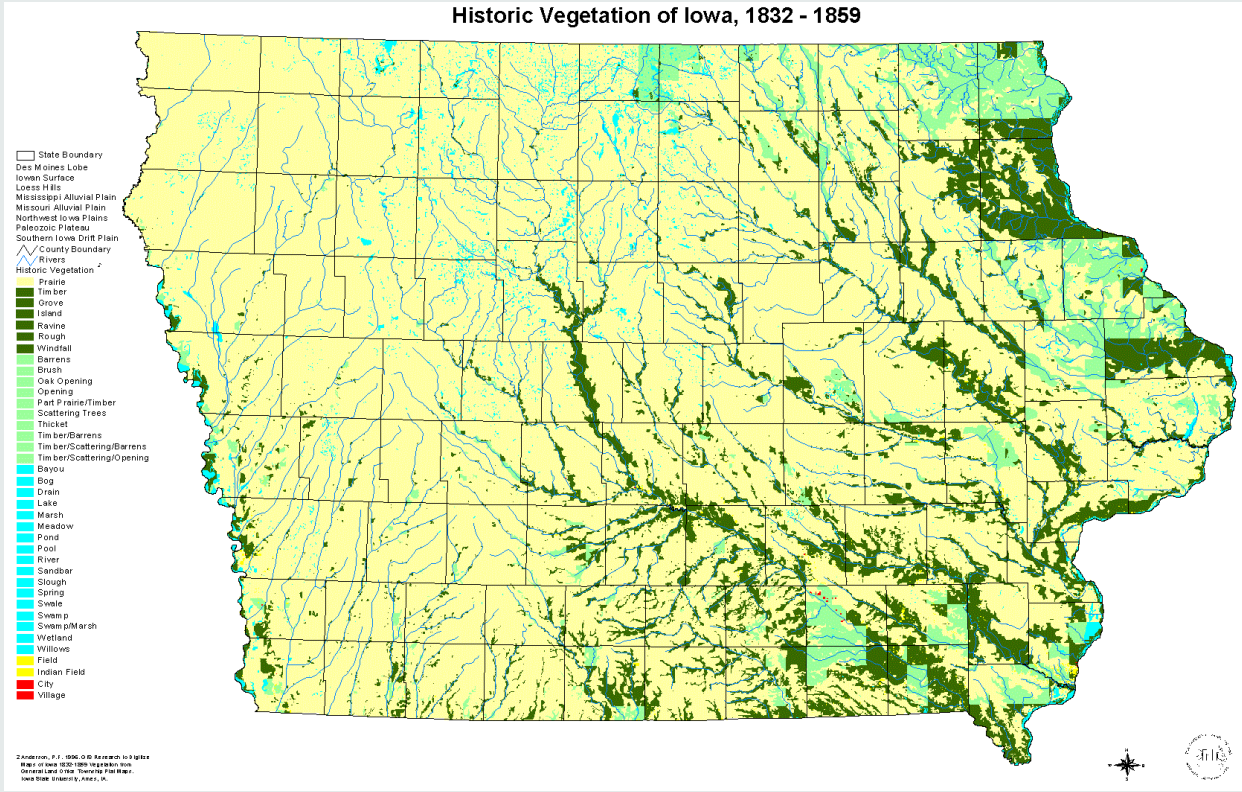
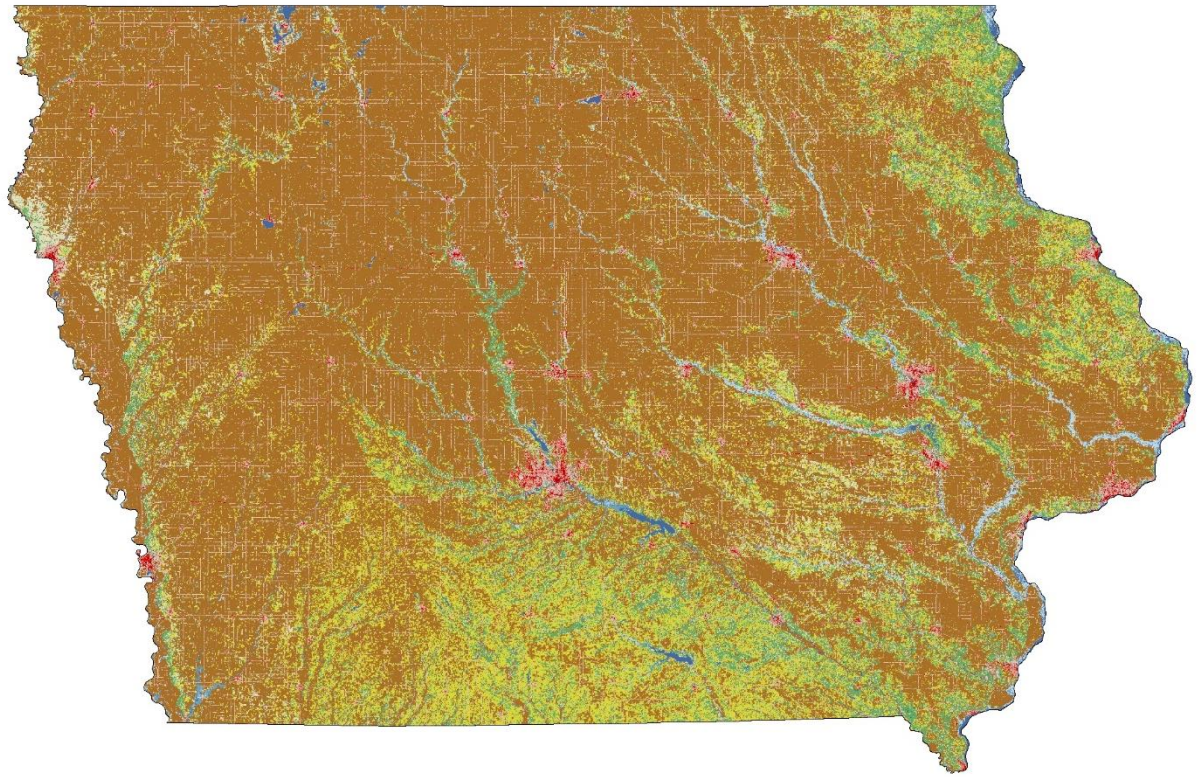
Prairie contour buffer strips serve as improved bird nesting habitat in Midwestern agricultural landscapes

Problem



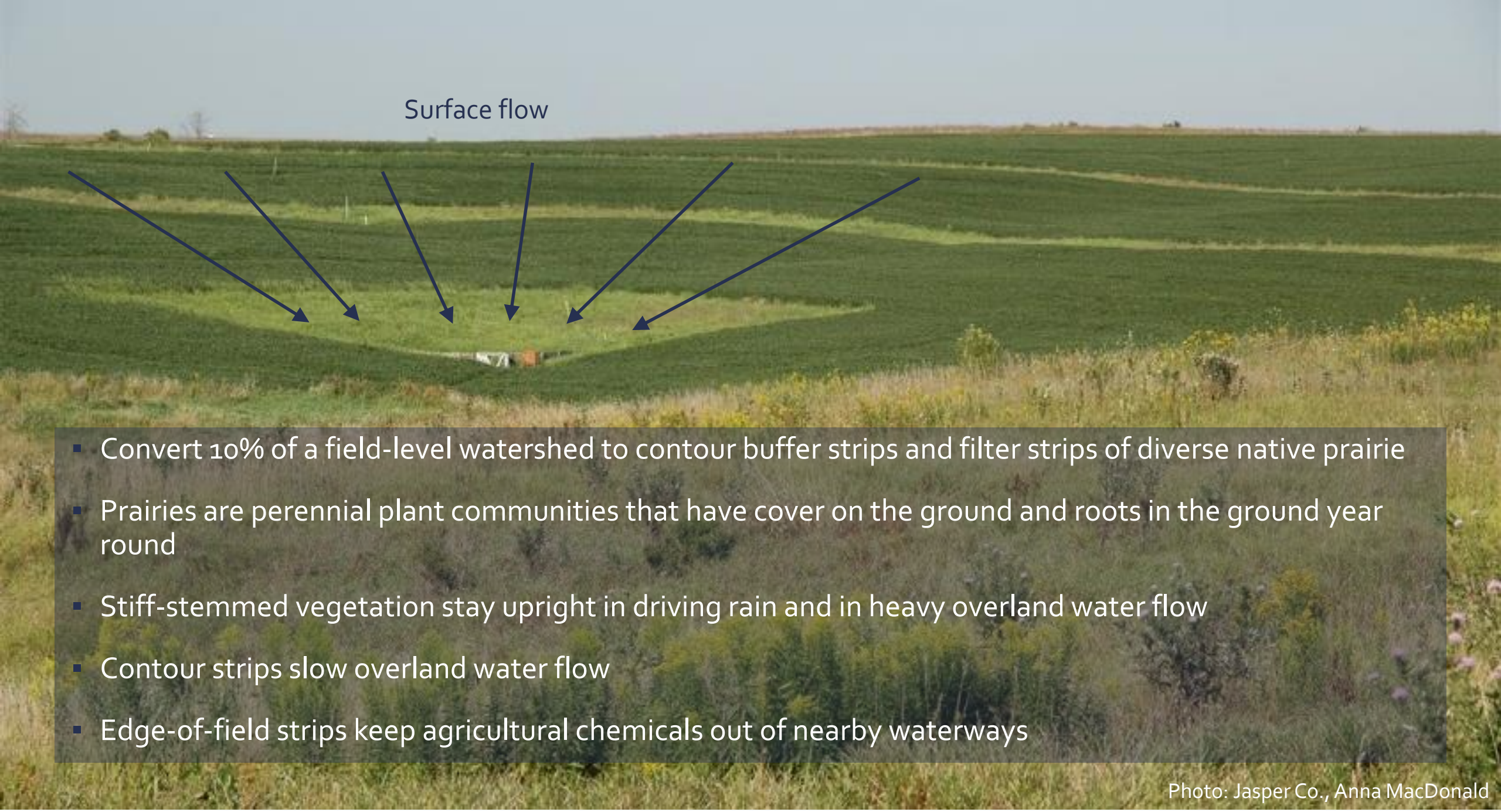


- Iowa was approximately 80% tallgrass prairie in the mid-1800's
- European settlers found the deep, rich prairie soils perfect for growing crops
- The landscape was systematically altered over the next 150 years
  - State is now 65% covered by row crop agriculture
  - Grass cover is around 5%
  - 0.1% of the original native tallgrass prairie remains, mostly in small patches

Image: Story County Iowa, Drake Larsen

Prairie STRIPS

Science-based Trials of Row-crops Integrated with Prairie Strips



- Convert 10% of a field-level watershed to contour buffer strips and filter strips of diverse native prairie
- Prairies are perennial plant communities that have cover on the ground and roots in the ground year round
- Stiff-stemmed vegetation stay upright in driving rain and in heavy overland water flow
- Contour strips slow overland water flow
- Edge-of-field strips keep agricultural chemicals out of nearby waterways

Photo: Jasper Co., Anna MacDonald

100% row crop

90% row crop/
10% prairie

100% prairie

Schulte, LA, JB Niemi, MJ Helmers, M Liebman, JG Arbuckle, DE James, RK Kokla, ME O'Neal, MD Tomer, JC Tyndall, H Asbjornsen, P Drobney, J Neal, G Van Ryswyk, C Witte. 2017. Prairie strips improve biodiversity and the delivery of multiple ecosystem services from corn-soybean croplands. Proceedings of the National Academy of Sciences. DOI 10.1073/pnas.1620229114

Disproportionate benefits

Conversion of only 10% of a row crop field to prairie strips results in:

- 44% reduced water runoff
- 84% reduced surface N runoff
- 90% reduced surface P runoff
- 2.9 times higher bird abundance
- 2.1 times as many bird species

…but wait!

- Are relatively narrow strips of prairie running through crop fields actually quality bird habitat?
- Are strips of habitat too “edgy”?
- Won’t predators be able to easily locate and destroy all the nests?
- Are prairie strips an improvement over any other grassy areas on farms?

Approach

Nest daily survival rate

- Estimate Daily Survival Rate (DSR) using a Maximum Likelihood approach in Program MARK (RMark)
- Evaluate model list using corrected AIC values and limit list to models whose 95% confidence intervals do not cross zero
- Need lots of nests:
  - Searched crop & grass areas on 10 farms around Iowa
  - Searches focused on prairie strips, traditional contour strips, and other grass areas
  - Any nests located were monitored until success or failure occurred
  - Three field seasons and counting (2015-2017)
- A variety of vegetation measurements were taken after nests succeeded or failed
- Landscape-level GIS covariates were also calculated

Plot searches for density estimation

- Fixed area plots were searched so nest densities could be directly compared between land cover types and species

- Plots were stratified by functional land cover
  - Cover crop (corn & soy)
  - Row crop (corn & soy)
  - Contour buffer strip
  - Prairie strip (narrow & wide)
  - Terrace
  - Block grassland

- Plot sizes were fixed by land cover
  - Most plots were 0.1 ha
  - Terrace plots were 0.05 ha due to a paucity of larger terraces
  - Crop plots were 0.2 ha because a much lower nest density was expected

Nest density estimation

- Based on protocol described by Smith et. al. (2009)
- Plots were searched once per week by alternating pairs of observers
- The pairs did not communicate presence or locations of nests to the other pair
- This allowed trials where one pair knew a nest was present and the other pair did not
- For example, if 1 in 5 trials resulted in a detection, we knew we were only finding 20% of the nests present
- Variables influencing detection probability were modeled using a logistic regression with a binomial response variable (detection/non-detection)
  - Covariates of interest included species, land cover, and vegetation density

What did we find?

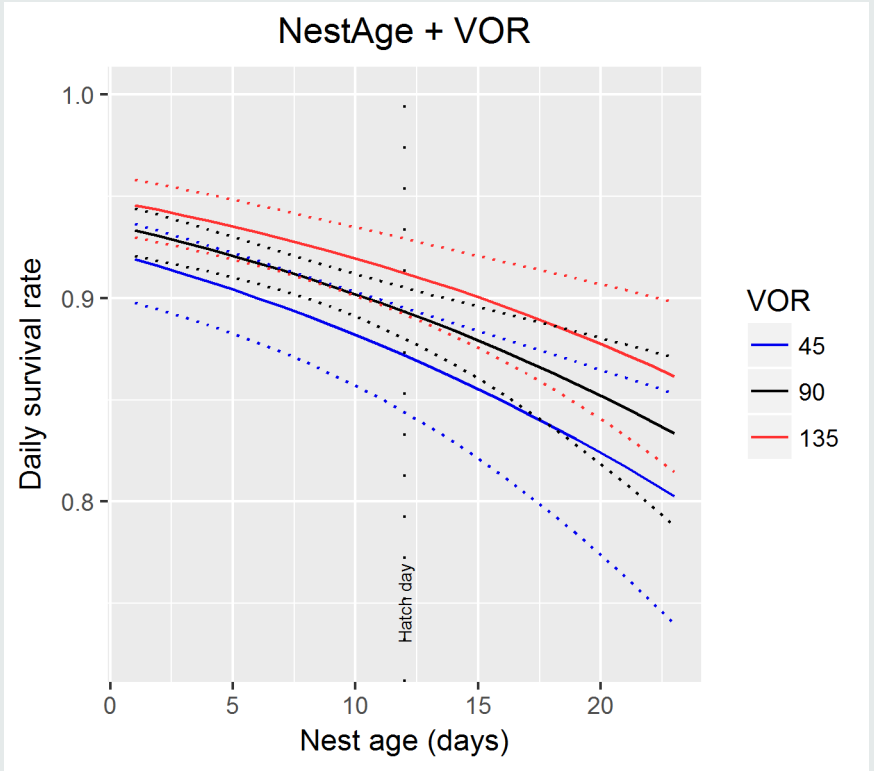
Nest survival

- From 2015-2017 we located and monitored 857 bird nests from 26 species on 10 sites in central Iowa
- Nest data sets large enough to model DSR:
  - Red-winged blackbird (357 nests)
  - Dickcissel (147 nests)
  - Vesper sparrow (49 nests)

Red-winged blackbird nest survival

- Best supported model was NestAge+VOR
  - NestAge was the age of the nest at every day
  - VOR was visual obstruction reading measured with a Robel pole at 5 meters
  - Received 80.1% of the model weight
- Next best model was NestAge alone
  - 2.88 delta AICc
  - 19.1% of model weight
- Next best VOR alone
  - 20.43 delta AICc
  - 0.003% of model weight
- Last was the null model
  - 22.69 delta AICc
  - 0.001% of model weight

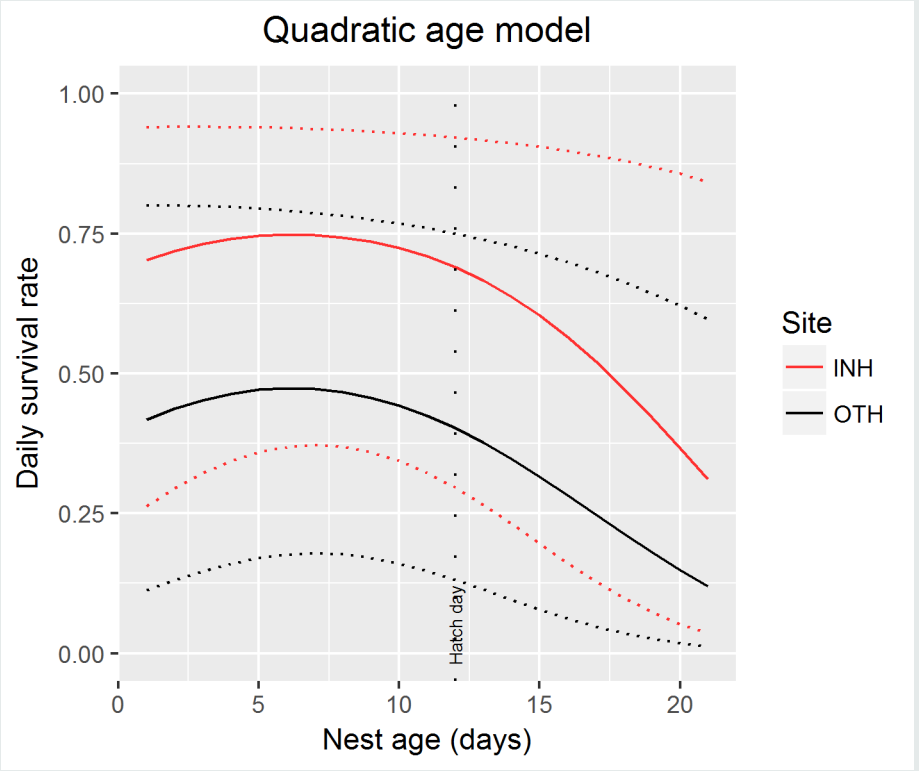
Model	# Parameters	AICc	DeltaAICc	weight	Neg2LnL
~NestAge + VOR	3	1885.93	0	0.80857	1879.92
~NestAge	2	1888.81	2.88	0.19139	1884.81
~VOR	2	1906.35	20.43	0.00003	1902.35
~1	1	1908.61	22.69	0.00001	1906.61



Dickcissel nest survival

- Best supported model was NestAge^2+NestAge+INH
  - NestAge^2+NestAge was a quadratic term for age of the nest on every day
  - INH was a grouping variable separating nests into those at the INH site and all other sites combined
  - Received 80.6% of the model weight
- Next best model was quadratic age + LumpSite
  - LumpSite grouped nests into 4 sites and a fifth group of all other sites combined
  - 5.62 delta AICc
  - 4.8% of model weight
- Next best was quadratic age + MatSTRIP
  - MatSTRIP was a grouping variable for nests found in mature prairie strips or block grasslands compared to everything else
  - 5.84 delta AICc
  - 4.4% of model weight

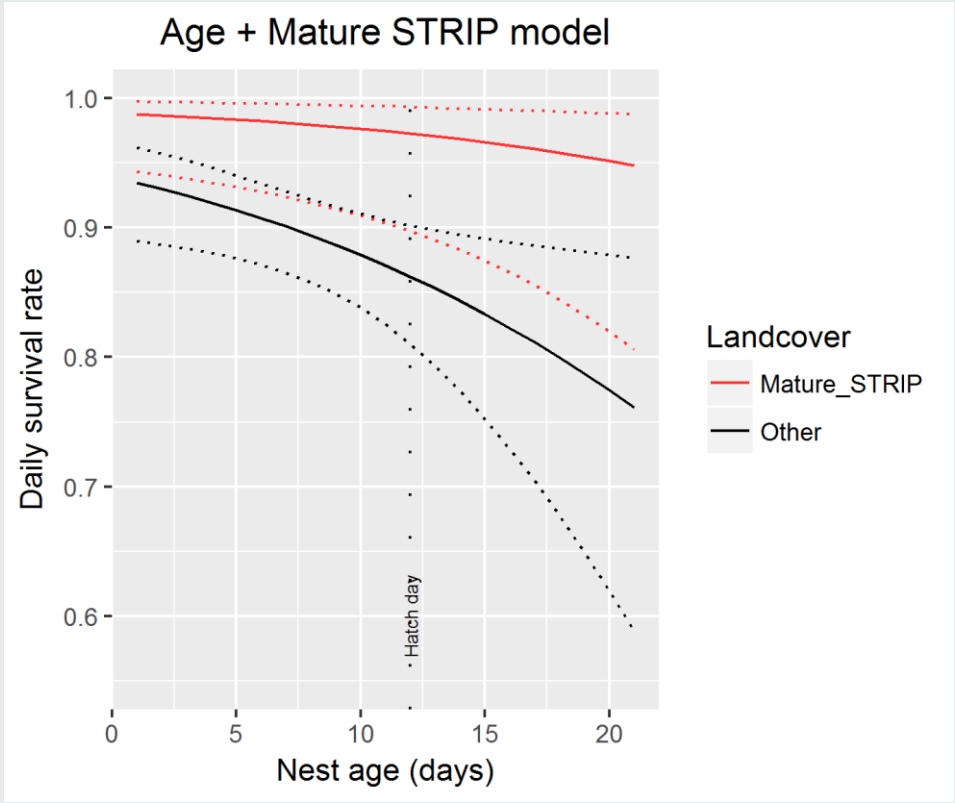
Model	# Parameters	AICc	DeltaAICc	Weight	Neg2LnL
~NestAge^2 + NestAge + INH	4	725.52	0.00	0.806	717.48
~NestAge^2 + NestAge + LumpSite	7	731.14	5.62	0.048	717.04
~NestAge^2 + NestAge + MatSTRIP	4	731.36	5.84	0.044	723.32
~NestAge + INH	3	731.59	6.07	0.039	725.57
~NestAge^2 + NestAge + mowed	4	731.77	6.25	0.035	723.74
~NestAge^2 + NestAge	3	733.77	8.25	0.013	727.74
~NestAge + INH	2	733.83	8.31	0.013	729.82
~mowed	2	738.43	12.91	0.001	734.42
~1	1	740.27	14.75	0.001	738.26



Vesper sparrow nest survival

- Best supported model was NestAge + MatSTRIP
  - NestAge was the age of the nest for each day
  - MatSTRIP was a grouping variable separating nests in mature prairie strips or grass blocks from nests in all other land covers
  - Received 85% of the model weight
- Next best model was a time trend variable
  - 4.78 delta AICc
  - 5% of model weight

Model	# Parameters	AICc	DeltaAICc	Weight	Neg2LnL
~NestAge+ MatSTRIP	3	246.01	0.00	0.85	239.96
~Time	2	250.79	4.78	0.08	246.77
~I(Time^2)	2	251.73	5.71	0.05	247.70
~1	1	253.55	7.54	0.02	251.54

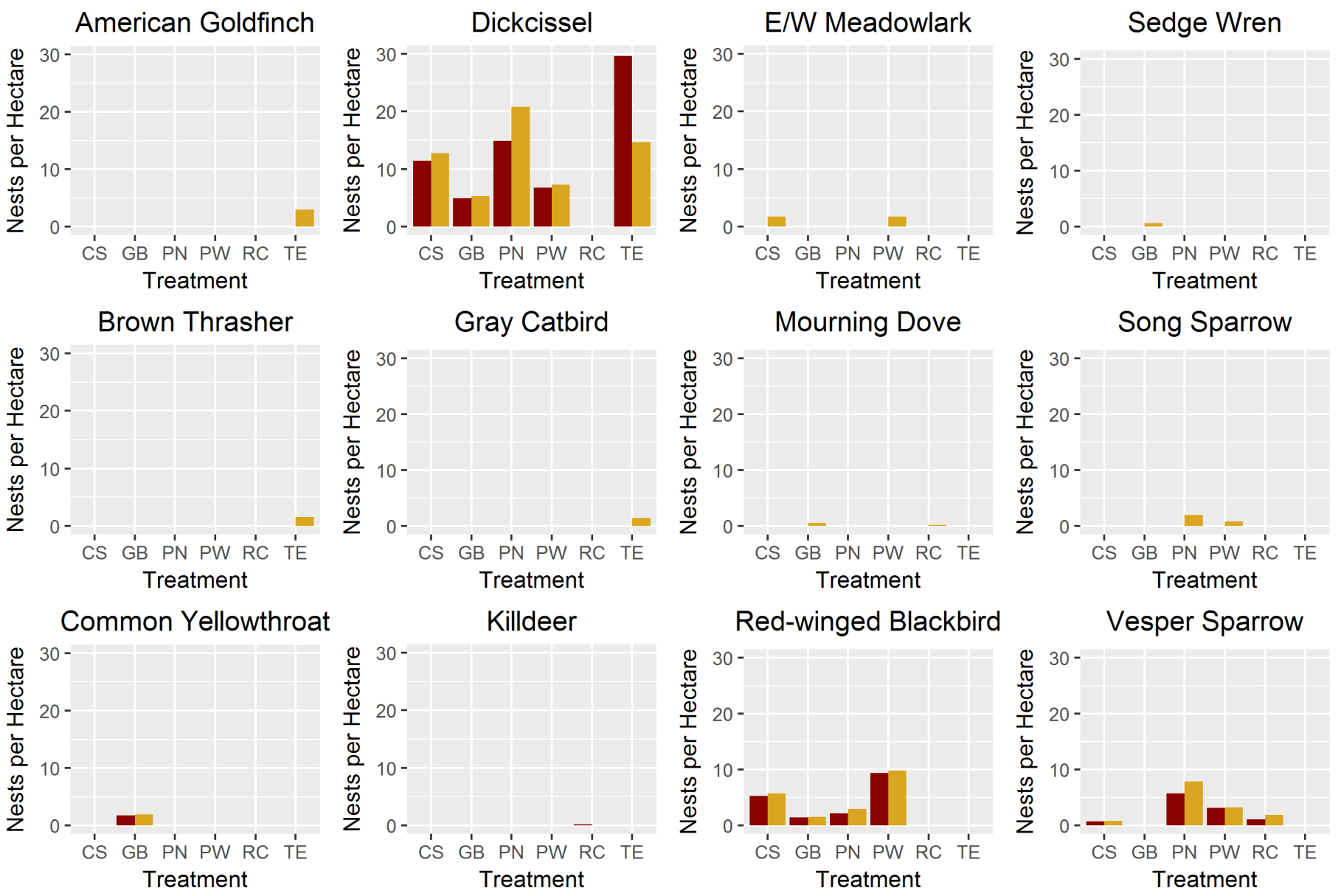


Nest density

- Searched 233 plots between 6-11 times from May – August 2016 & 2017
- 2866 plot searches total
- Discovered 114 nests in plots during searches
  - Also 17 nests in plots outside of formal searches
- Resulted in 79 detection trials
  - (not all nests survived one week until the next pair of observers could search)
  - 15 re-detections

Nest density estimates

- Raw detection probability was 0.19
- AIC model selection on generalized linear regression with a binomial response variable used to determine significant covariates on detection probability
  - Field season was the only significant predictor
  - 2016 (red)
  - 2017 (yellow)



Conclusions

Nest survival

- Nest survival for red-winged blackbirds was higher in younger nests and higher for nests constructed in denser vegetation
  - Location within a prairie strip was not a good predictor of success on its own, but prairie strips did generally have more dense vegetation than brome grass contour strips

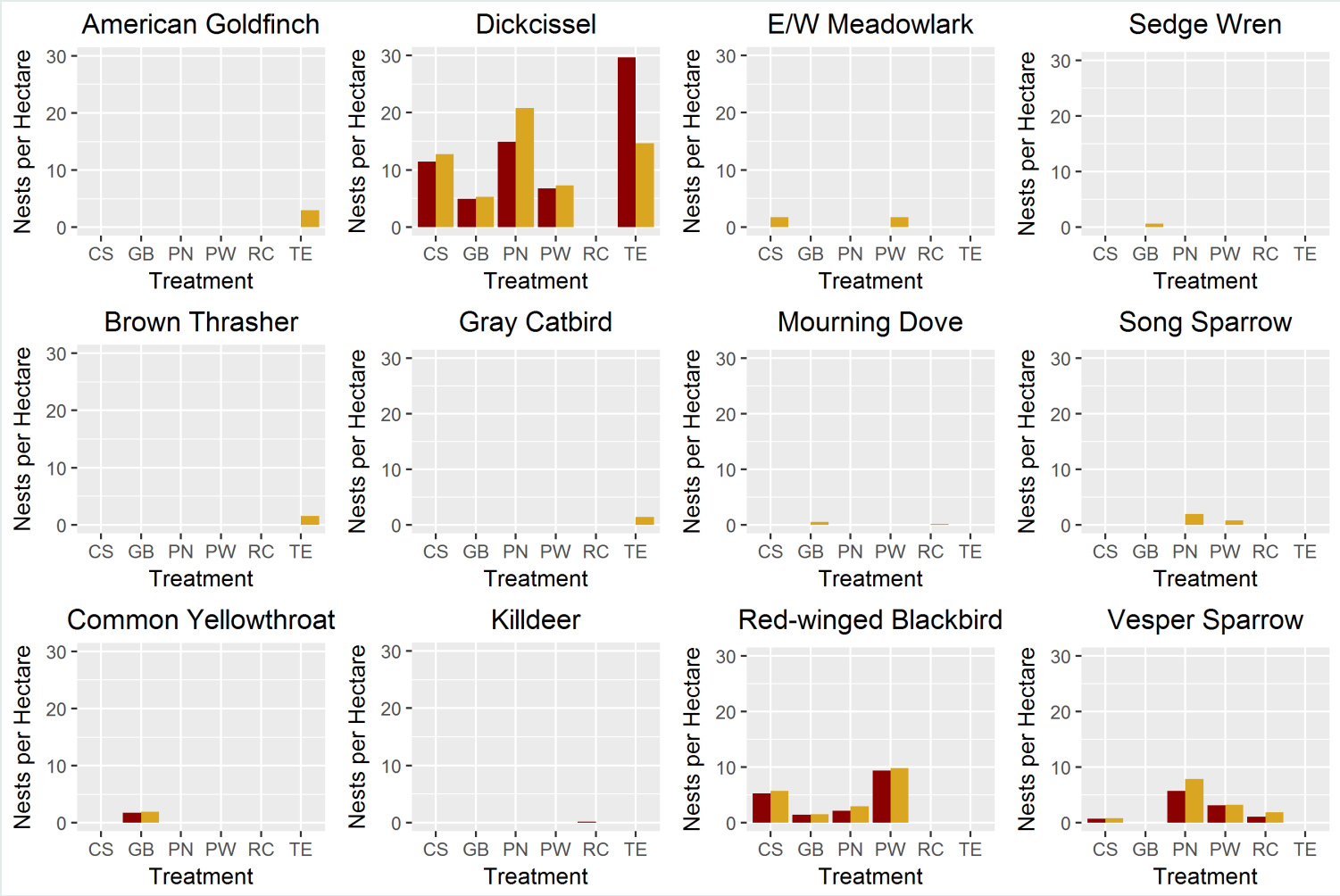
- Nest survival for dickcissels peaked between days 5-7 and was higher at INH site than other sites
- All nests found at INH were in a single diverse, wide (70-100 m), mature (>5 yr) prairie strip
- We had other prairie strips at other sites with similar characteristic
  - Plant diversity, width, and maturity
  - The single site variable was more parsimonious in model selection than a combination of multiple variables

Vesper sparrow nest survival

- Vesper sparrows nests had the highest daily survival rate for younger nests and those located in mature prairie strips
- Generally thought of as an open country or short grass nester
- Could potentially be taking advantage of the nearby crop edge
- Small sample size (49 nests)

Nest density

- Dickcissel nest density highest in terraces and narrow prairie strips followed by contour strips
  - Potentially an artifact of higher detection probabilities in narrow features that wasn't captured in our modeling process
- Blackbird density highest in wide prairie strips followed by contour strips
  - High density in wide prairie strips probably due to several wide prairie strips located next to water bodies
- Vesper sparrow densities highest in narrow prairie strips followed by wide prairie strips
- Larger sample sizes needed to better model detection probabilities and obtain more accurate density estimates



Prairie STRIPS are quality bird nesting habitat

- Red-winged blackbird nests survive at higher rates when located in dense vegetation, such as the vegetation found in prairie strips
- Dickcissel nests survive longer at a site with an exemplary prairie strip compared to other farms, and also survive longer in mature prairie strips than in other land covers
- Vesper sparrow nests survive longer in mature prairie strips than in other land covers
- Preliminary nest density estimates
  - Red-winged blackbird nests are more dense in wide prairie strips than other land cover types
  - Dickcissel nests are more dense in narrow grass features, although this could be an artifact of higher detection probabilities in those areas
  - Vesper sparrow nests are more dense in prairie strips than other land cover types

Other STRIPS wildlife studies

Ongoing STRIPS wildlife studies

- Bird density estimations through point counts (Julia Dale & Jordan Giese, ISU)
- Bird occupancy and community analysis using Autonomous Recording Units (Julia Dale & Jordan Giese, ISU)
- Reptile, amphibian, and small mammal occupancy using cover boards (Matt Stephenson, ISU)
- Mammalian nest predator surveys using trail cameras (Matt Stephenson, ISU)
- Ring-necked pheasant winter habitat use using GPS telemetry (Jordan Giese, ISU)
- Pollinator and predatory insect abundance and occupancy using sweep nests and bowl traps (Morgan Mackhert & Farnaz Kordbacheh, ISU)
- Honey bee, native bees, and Monarch research (Ge Zhang & Maura Hall, ISU)

Thank you!

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Committee on Agricultural Development

Vegetation measures collected

- For every point of interest (nest, cover board, bird point count station, ARU):
  - 4 measurement points: next to the point of interest, 5 m north, 5 m at 120°, 5 m at 240°
    - A 1^2 meter quadrat where plants were identified and coverages estimated by species
    - Coverages estimated by grass, forb, litter, dead veg, bare ground, or water
  - Once per point of interest:
    - Visual Obstruction Reading (VOR) using a Robel pole next to the point of interest measured at 5m in 4 directions
    - List of plant species present that did not occur within one of the four quadrats
- GIS data for every site
  - Land cover maps with ~20 functional land cover classes